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AUTHOR Kilmer, Donald C.
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ABSTRACT

A primarily illustrated introduction to the basics of electricity is presented in this guide, the first of a set of four designed for the student interested in a vocation in electrical work. This guide is intended for the first-year student and provides mostly diagrams with accompanying defintions/information in three units, each covering one of the following areas: shop safety; tools for the electrician (hand tools, tool-box tools); and electrical symbols and circuits (symbol identification, electric circuits, electric circuits using symbols, series and parallel circuits). Each unit includes from one to four lessons with each lesson including a behavioral objective, vocabulary, lesson information, and an assignment, where applicable. (SH)

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Basic Electricity

Part 1

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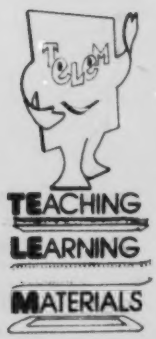

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TO THE TEACHER

This book is an introduction to the basics of electricity. It is written for the first year student, to introduce him or her to the beginning of a vocation in electrical work. Depending upon the student's interest and ability, it may direct him or her toward employment in a manufacturing facility, as an electrician's helper, or even as a full-fledged electrician.

For all of these students, and even for those who choose not to continue in this field, it is my hope that the ultra simplicity of this text will provide an understanding of electricity and contribute to their general education.

The text has been divided into four separate books, which should be taught in order. The division has been made as an encouragement to the students: they have greater confidence in their ability to master smaller segments, and they have a greater sense of satisfaction upon completing a whole book rather than merely a few units of a book.

Donald C. Kilmer

TO THE STUDENT OF ELECTRICITY

Electricity is an interesting subject; there is a lot to learn about it.

This first year course gives the basic information you will need as a student of vocational electricity. First, read the table of contents, then carefully look through the book. It will help you to know what you are going to learn.

Do not be in a hurry to complete this text. If you find any part too difficult, ask your teacher for help. Review each lesson as many times as you need to. When you understand it, complete the assignment.

Remember, without a good start, you have nothing to build on. With a good start, you can learn more and more in the future.

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SHOP SAFETY

THINK SAFETY FIRST!

UNIT 1

Developing Safety Habits **Lesson 1**

OBJECTIVE:

When you have completed this lesson, you will be able to describe good safety habits to follow in the shop.

VOCABULARY:

acrobat (ak'-ra-bat) – a person who climbs on things above the ground.

cracked (krakt) – broken, fractured.

shock (shok) – a sudden surprise that could cause injury.

INFORMATION:

Safety is part of your job.

Practice the *rules of safety* on the following pages.

You will *see* how to *protect* yourself and *other people* from being *hurt*.

PRACTICE YOUR SAFETY RULES.

Wear your safety glasses.

Roll up your sleeves when you work.

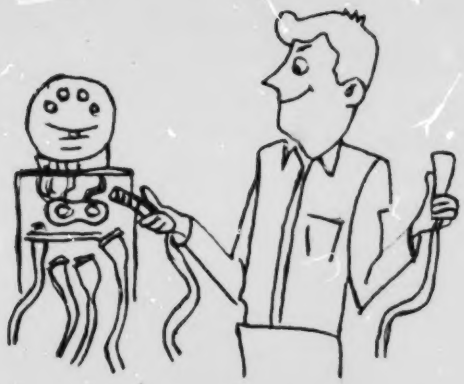
Never wear a necktie when you work on machines.

Don't leave tools on the floor.

Never leave tools on a ladder.

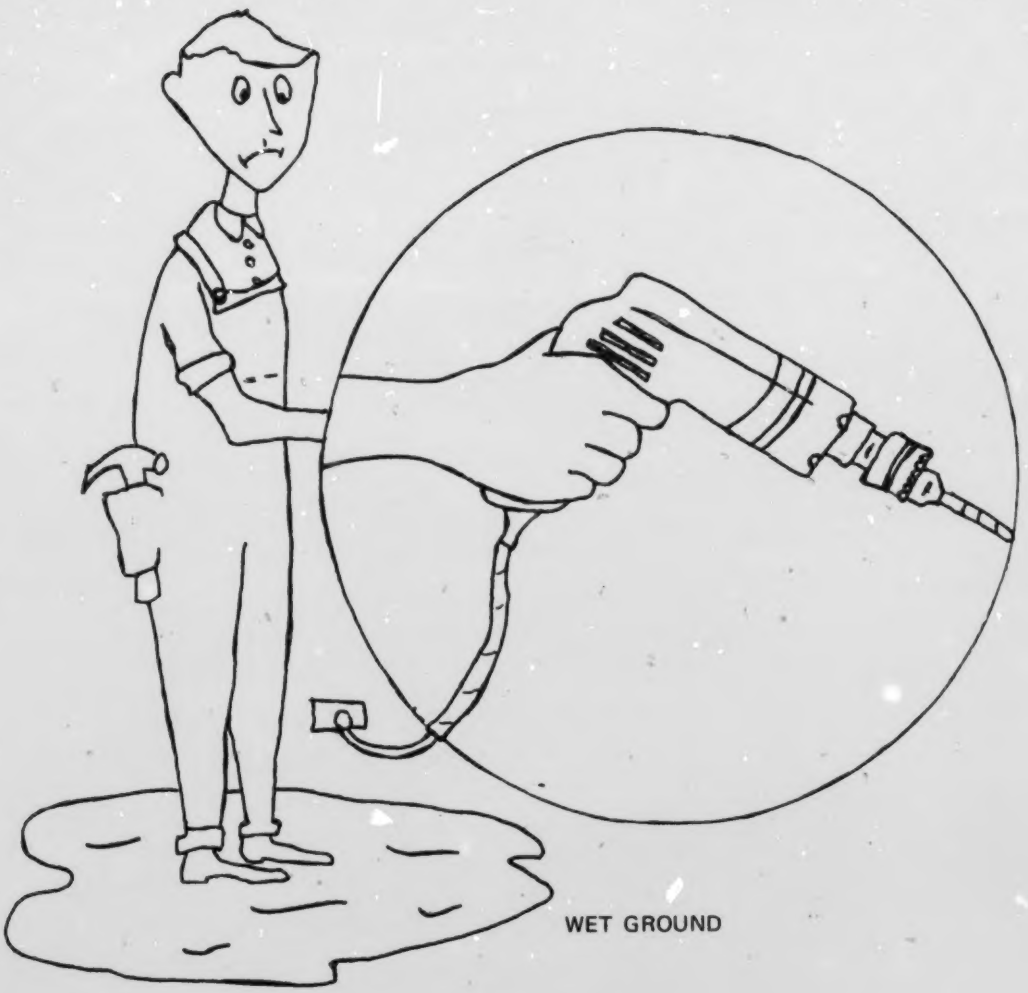
Check all ladders for cracked rungs.

Don't be an acrobat. Work safely. Use a ladder.



Use a tester.

Never test a circuit with your



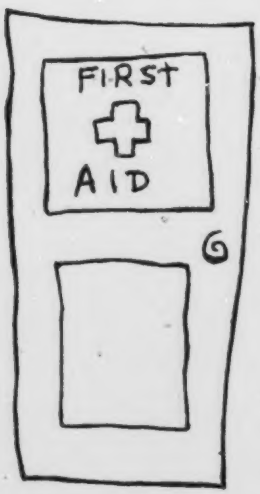
WET GROUND

Never stand on wet ground when you use electricity. You may get a shock and die.

Keep your mind on the job.

Do not overload yourself. Carry only what you can.

Do not play in the shop. It may be you who gets hurt.



If you get hurt, get first aid.

QUESTIONS:

1. You must wear safety glasses to protect your _____.

2. Never test a circuit with your _____.

3. You can get a _____ if you stand on _____ ground when you use electricity.

4. If you get hurt, get _____ _____.

5. Do not leave tools on top of a _____ _____.

6. You may lose an _____ if you play in the shop.

TOOLS FOR THE ELECTRICIAN

UNIT II

Hand Tools **Lesson 1**

OBJECTIVE:

When you complete this lesson, you will be able to name and identify electrician's hand tools.

VOCABULARY:

identify (ī-den'-ti-fī) – to tell what a thing is.

insulation (in-sə-lā'-shən) – a covering around the wire to protect you from electric shock.

leather (leŦH-ər) – the material an electrician's pouch is made from; animal skin.

non-metallic (non-me-tal'-ik) – not metal.

pouch (pouch) – a leather bag.

remove (re-müv') – take away; take off.

scrape (skrāp) – to rub with a sharp tool, to clean electric wire.

waist (wāst) – the middle part of your body.

INFORMATION:

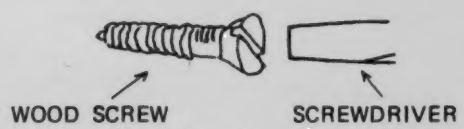
Hand tools are the tools a good electrician carries with him at all times while he works. Hand tools are carried in a leather pouch. The leather pouch hangs from a belt around the electrician's waist. Study the following tools until you can name each one from memory.

A tool pouch holds your hand tools.

STRAIGHT-BLADE SCREWDRIVER

(strāt-blād skrü'-drīv'-ər)

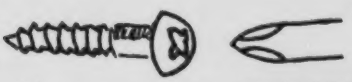
A straight-blade screwdriver turns slotted screws.



PHILLIPS SCREWDRIVER

(fil'ips)

A Phillips screwdriver turns Phillips-head screws.



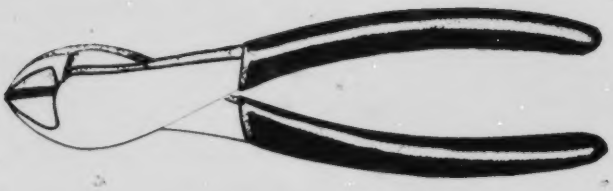
PHILLIPS-HEAD SCREW PHILLIPS SCREWDRIVER

LINEMAN'S PLIERS
(līn'-mənz plī'-ərz)
OR SIDE CUTTERS

Lineman's pliers are used to cut thick and thin wires.

HEAVY WIRE

THIN WIRE



DIAGONAL PLIERS

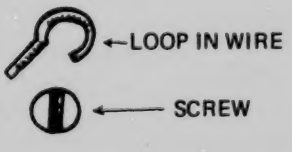
(dī-ag'-ə-nəl)

Diagonal pliers are used to cut thin wire.

NEEDLE-NOSE PLIERS

(nē'-dl) nōz)

Needle-nose pliers are used to bend loops in wire to put around screws.



PUMP PLIERS

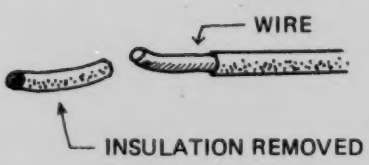
Pump pliers are used to tighten lock nuts and other pipe fittings.

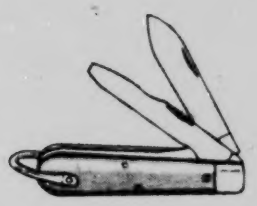
LOCK NUT

WIRE STRIPPERS

(wīr strip'-ərz)

Wire strippers are used to remove insulation from wires.





KNIFE

(nīf)

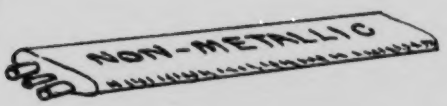
A knife is used to remove insulation and scrape wire clean.

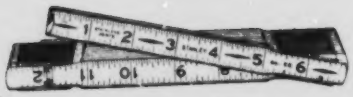
SCRAPING WIRE

CABLE RIPPERS

(kā'-bl rip'-ərz)

Cable rippers are used to remove insulation from non-metallic cable.

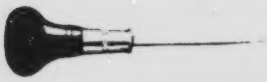




FOLDING RULE

(fōld'-iṅg rül)

Folding rule is used by electricians because it is easier to carry in a pocket.



AWL

(ôl)

An awl is used to start a hole in wood for wood screws.

ASSIGNMENT:

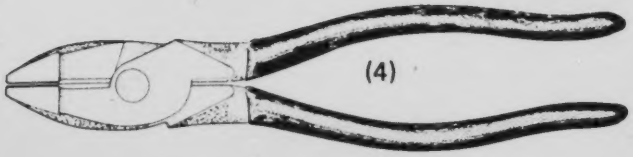
Match each picture with the name of the tool on the next page.

(1)

(2)

(3)

(4)



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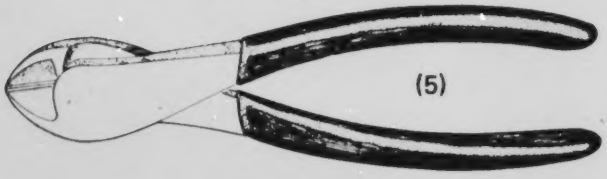

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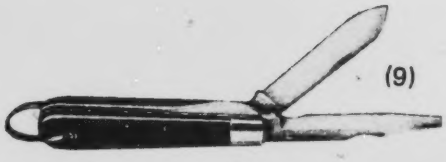


(10)

(11)

(12)

Write the number of each tool from the last page.

_____ Diagonal pliers

_____ Phillips-head screwdriver

_____ Tool pouch

_____ Awl

_____ Folding rule

_____ Lineman's pliers

_____ Straight-blade screwdriver

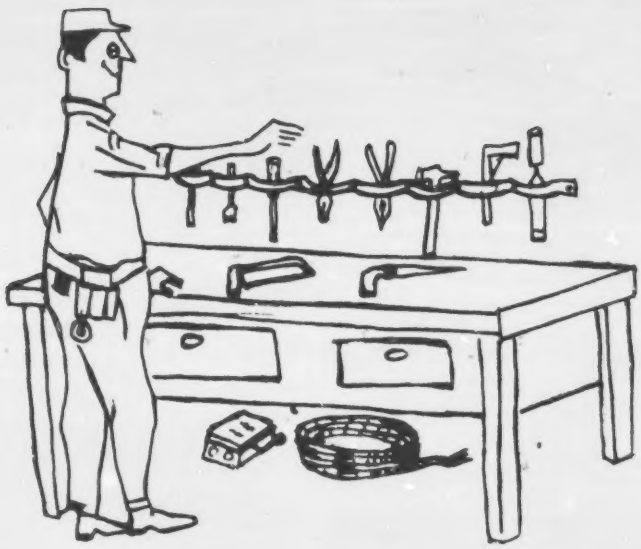
_____ Needle-nose pliers

_____ Knife

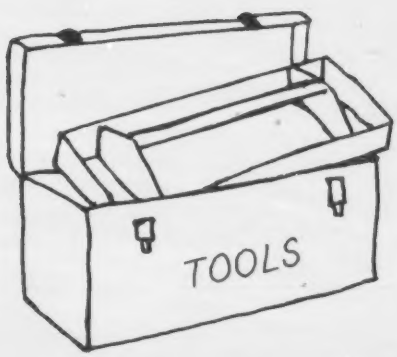
_____ Pump pliers

_____ Wire strippers

_____ Cable rippers



CHOOSE THE RIGHT TOOLS.



KEEP THEM IN YOUR TOOL BOX.

UNIT II – TOOLS FOR THE ELECTRICIAN

Tool-Box Tools **Lesson 2**

OBJECTIVE:

When you finish this lesson, you will be able to list the tools to keep in your tool box. You will know the names of the tools and know how to use the tools.

INFORMATION:

The tools in this lesson are kept in your tool box.

They are not used as much as hand tools, so choose the right tools and you will have them for a long time.

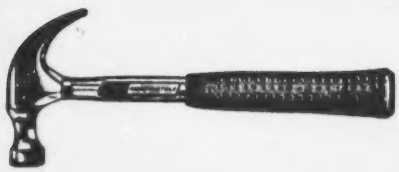
They are important tools.

Take care of them.

Keep them clean.

If they have grease or dirt on them, wipe it off.

Study the following tools until you can name each one from memory.



CLAW HAMMER

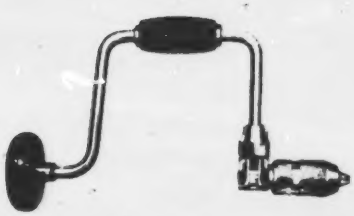
(klô ham'-ər)

A hammer drives nails and staples.

STUBBY SCREWDRIVER

(stub'i)

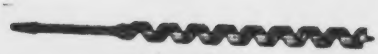
A stubby screwdriver is short, so you can use it in narrow places.



HAND BRACE

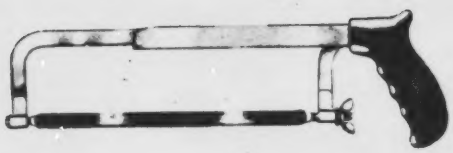
(hand brās)

A wood brace holds the auger bit.



WOOD BIT

A wood bit drills holes in wood.



HACKSAW

(hak′-sô)

A hacksaw cuts metal and pipe.

KEYHOLE SAW

(kē′-hōl)

A keyhole-saw blade has a pointed tip. It fits into drilled holes.

ADJUSTABLE WRENCH

(ə-just′-ə-bl rench)

An adjustable wrench is made to fit different size nuts.

VISE-GRIP PLIERS

(vīse grip plī′ərz)

Vise-grip pliers are used as a hand vise.

WOOD CHISEL

(wûd chiz'l)

A wood chisel is used to help you cut holes in wood.

FILE

(fīl)

A file is used to smooth rough metal and to sharpen tools.

FISH TAPE AND REEL

(fish tāp rēl)

A fish tape is used to pull wire through conduit.

CONDUIT BENDER

(kon′dü-it bend′-ėr)

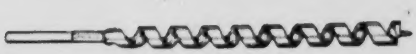
A conduit bender bends pipe.

41

ELECTRIC DRILL

(e-lek′-trik dril)

An electric drill is used to make holes when you have electricity on the job.



ELECTRIC DRILL BIT

This electric drill bit is used in electric drills.

ZIP BIT

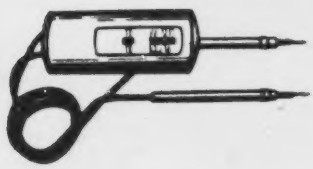
(zip bit)

A zip bit is used to drill holes in wood. It drills fast.

FUSE PULLERS

(fūz půl'-ərz)

Fuse pullers are used to remove some fuses.



VOLTAGE TESTER

(vōl'-tij test'-ər)

Voltage testers are used to measure volts.

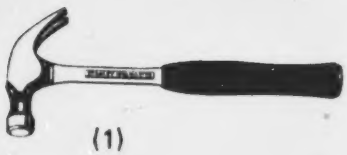
FLASHLIGHT

(flash'-līt')

A flashlight is used when you don't have electricity on the job.

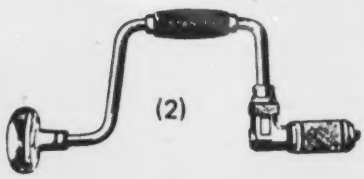
ASSIGNMENT:

Match each picture with the name of the tool on the next page.



(1)

(6)



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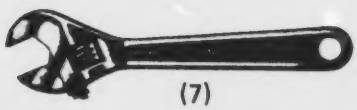
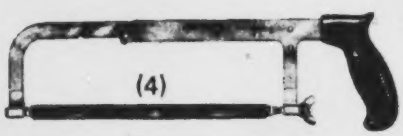


(7)

(3)

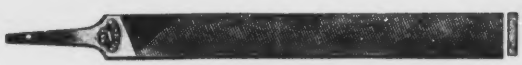
(8)



(4)

(9)

(5)



(10)

Write the number of each tool from the last page.

_____ Vise-grip pliers

_____ Stubby screwdriver

_____ Hand brace

_____ Keyhole saw

_____ Hacksaw

_____ Adjustable wrench

_____ Wood bit for hand brace

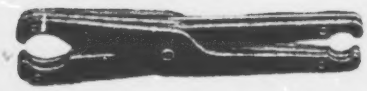
_____ Wood chisel

_____ Claw hammer

_____ File

ASSIGNMENT:

Match each picture with the name of the tool on the next page.



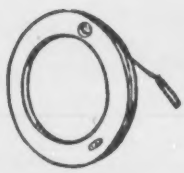
(1)

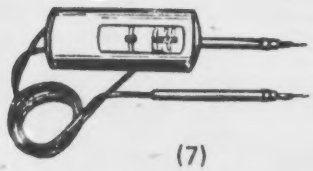
(5)

(2)

(6)

(3)





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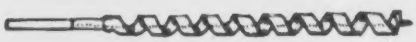

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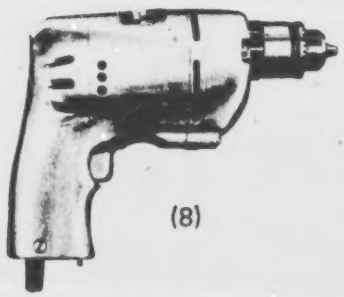


(8)

Write the number of each tool from the last page.

_____ Voltage tester

_____ Fuse puller

_____ Conduit bender

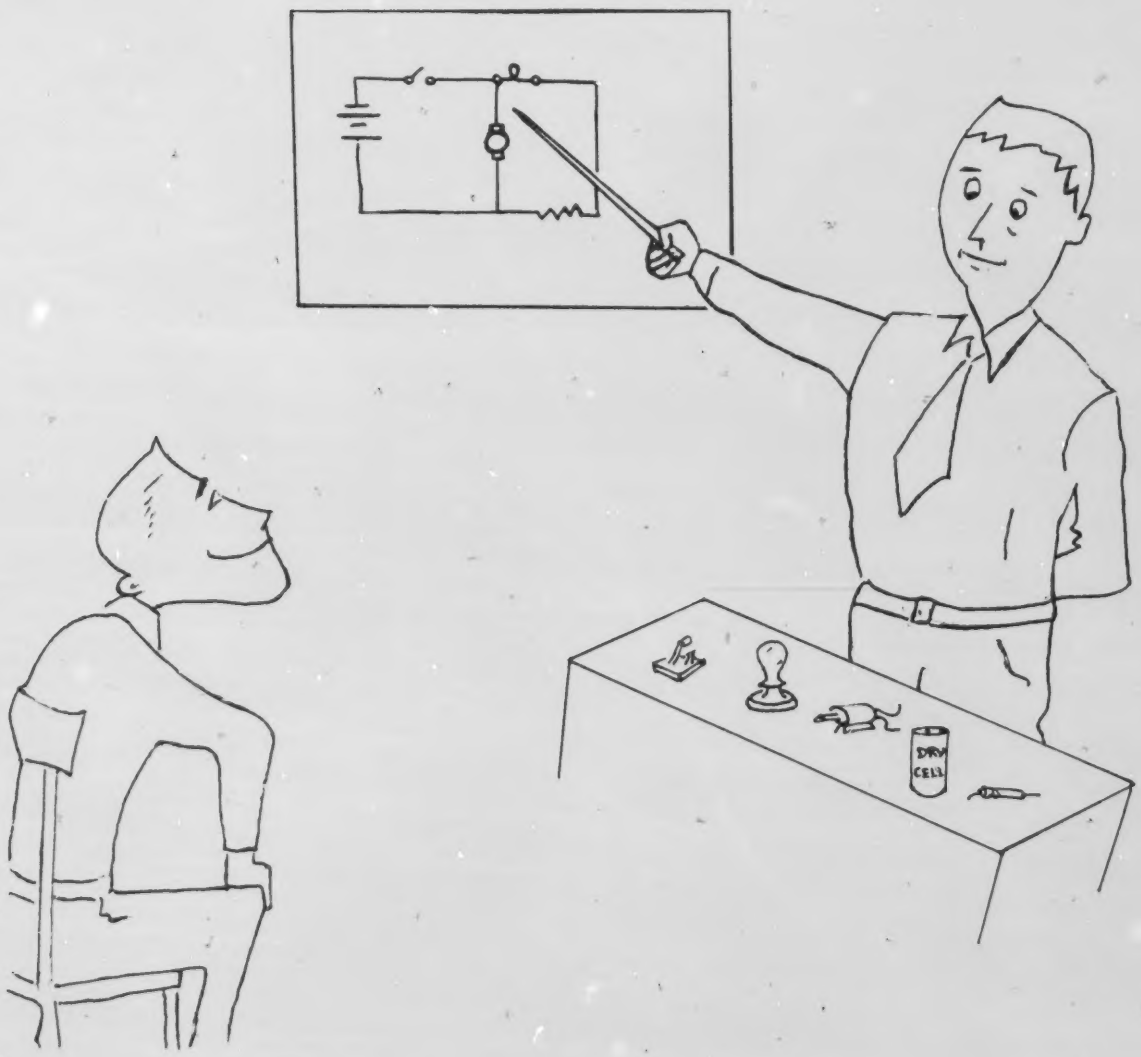
_____ Flashlight

_____ Fish tape and reel

_____ Zip bit

_____ Wood bit for electric drill

ELECTRICAL SYMBOLS AND CIRCUITS



UNIT III

UNIT III – ELECTRICAL SYMBOLS AND CIRCUITS

Symbol Identification **Lesson 1**

OBJECTIVE:

When you have completed this lesson, you will know how to identify an electrical object or picture by its symbol.

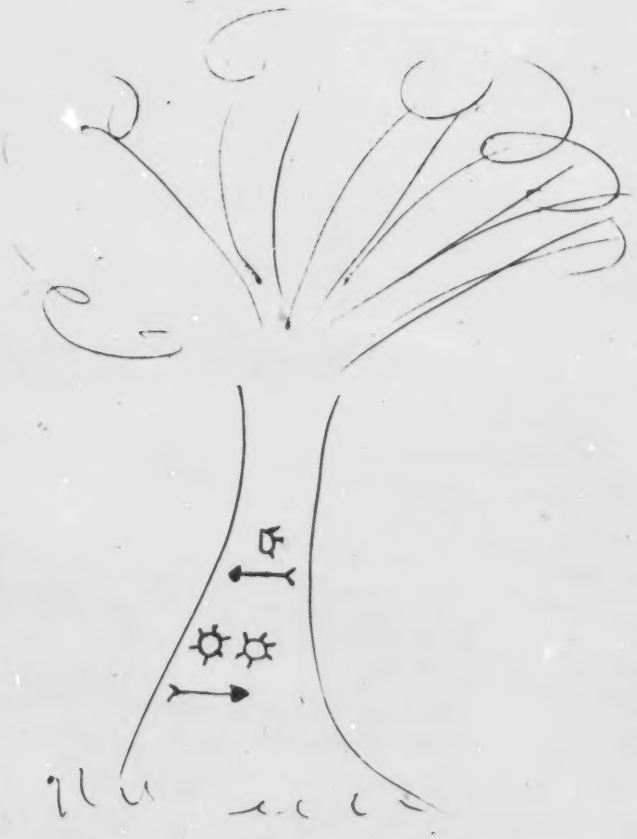
VOCABULARY:

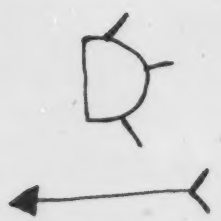
direction (di-rek'-shun) – telling what to do, how to do, where to go.
object (ob'-jekt) – something you can see or touch; it is a real thing.
symbol (sim'-bl) – an easy way of drawing something; it always means that thing.

INFORMATION:

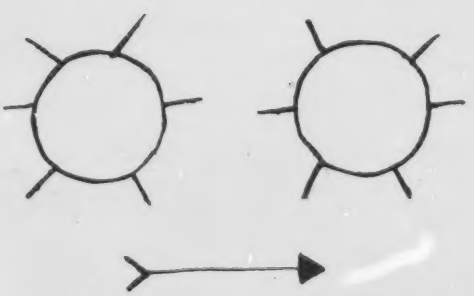
Symbols take the place of something else. The marks +, –, x, and ÷, are symbols for add, subtract, multiply, and divide.

Years ago Indians wrote letters to each other with symbols. They carved pictures on trees. A half sun means a half day. A full sun means one day. The arrow points to the direction they are traveling.





Went at noon



Be back in two days

A symbol is a quick and clear way of drawing electrical objects.

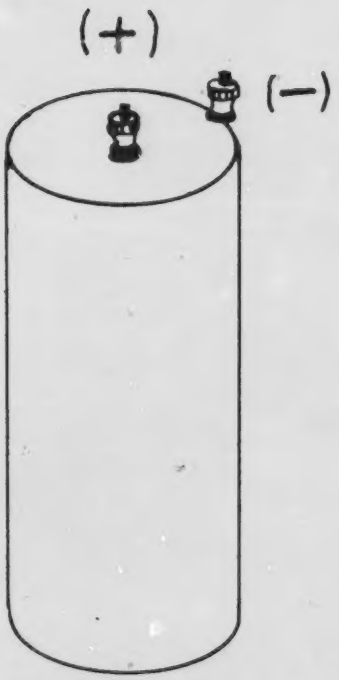
Symbols are easy, clear, and fast to draw.

Objects are slow and hard to draw.

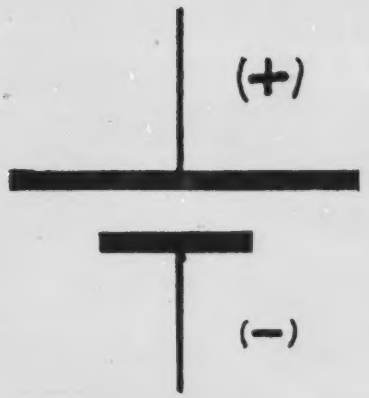
An electrical object is a real thing. All electrical objects in this unit have *symbols*.

The picture on the left is a battery, or object.

The picture on the right is its symbol.



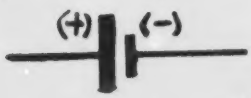
ELECTRICAL OBJECT

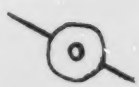


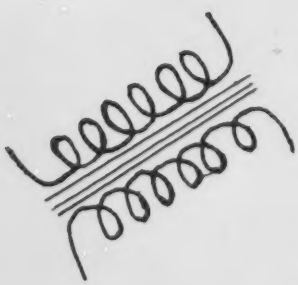
SYMBOL

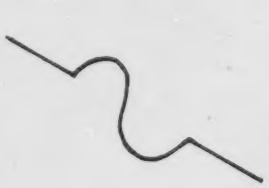
BATTERY

SYMBOLS

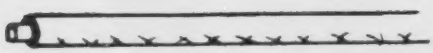
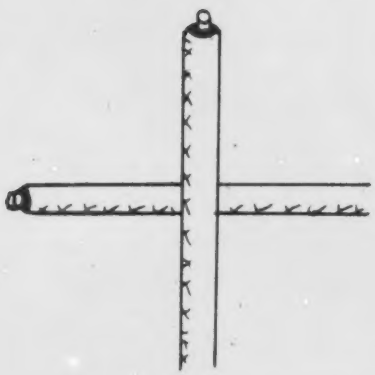
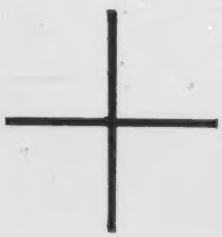




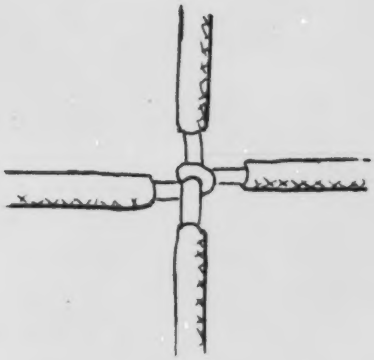




Study the following pictures and their symbols:

Picture	Symbol
	
WIRE (wīr)	
	
WIRES CROSSED (wīrz krost)	

Picture **Symbol**

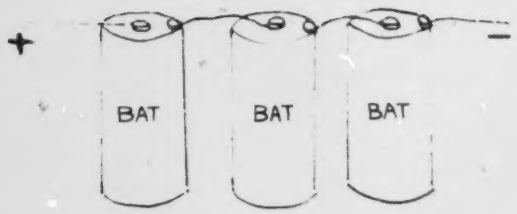


WIRES CONNECTED (wīrz kə-nekt'id)

BATTERY (bat'-ə-ri)

Picture

Symbol

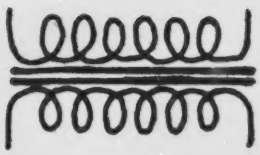


BATTERIES

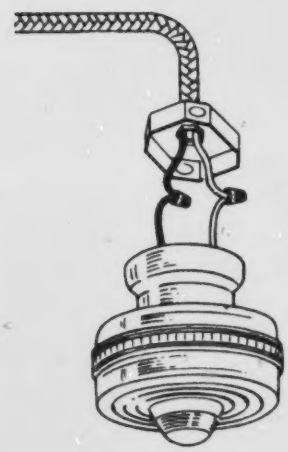
SWITCH (swich)

Picture

Symbol

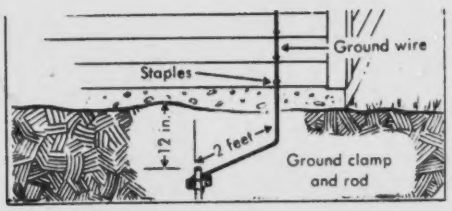


TRANSFORMER (trans-fôrm'-ər)

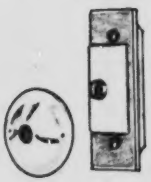


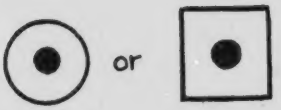
LIGHT (līt)

Picture **Symbol**



GROUND





PUSHBUTTON (půsh'-but-tn)

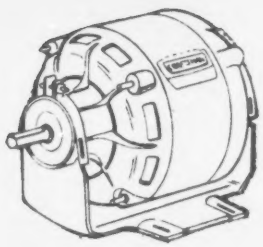
Picture

Symbol

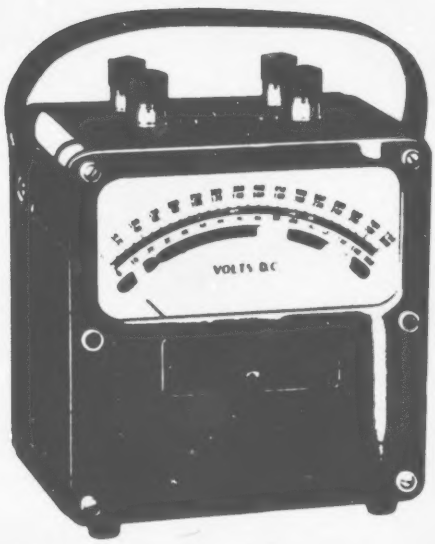
BELL (bel)

BUZZER (buz'-ər)

Picture **Symbol**



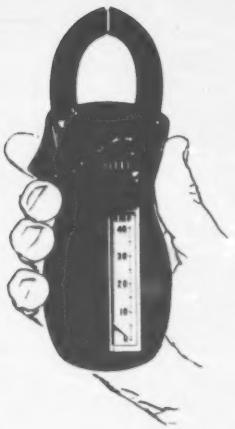
MOTOR (mō'tər)



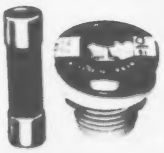
VOLTMETER (vōlt'mē'tər)

Picture

Symbol



AMMETER (a' -mē-t ər)

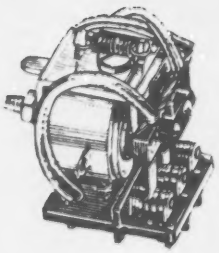


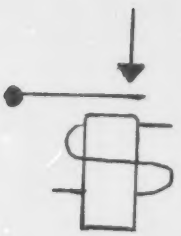
FUSE (fūz)

Picture

Symbol

CIRCUIT BREAKER (sėr'kit brāk'ər)

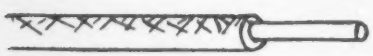




RELAY (rē'lā)

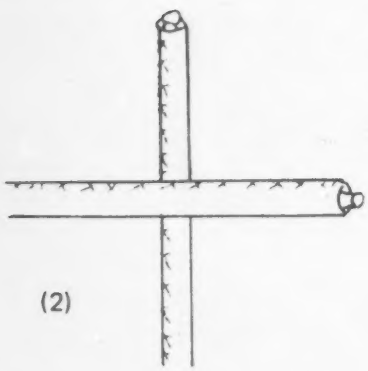
ASSIGNMENT:

Match the picture with its symbol. Write the number of the picture on the blank line below the symbol on the next page.

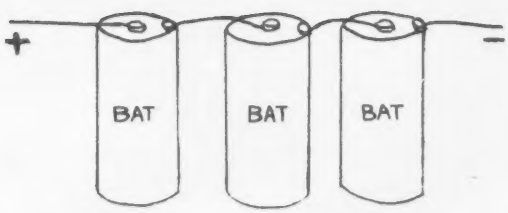


(1)

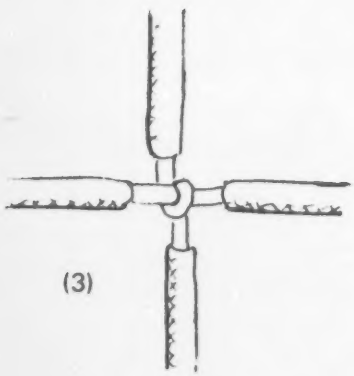
(4)



(2)



(5)



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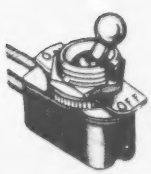

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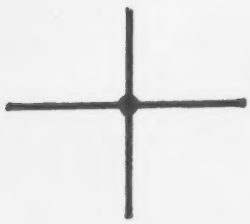
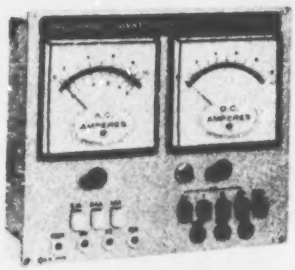


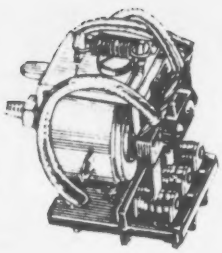
ASSIGNMENT:

Match the picture with its symbol. Write the number of the picture on the blank line under the symbol on the next page.

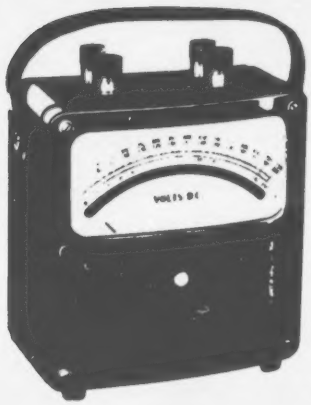
(7)



(11)

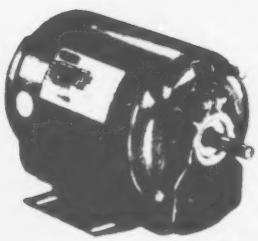


(3)

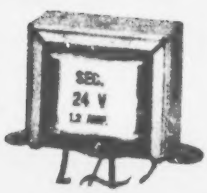


(12)

(9)



(10)



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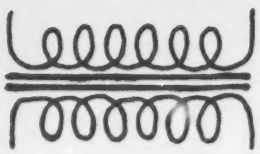
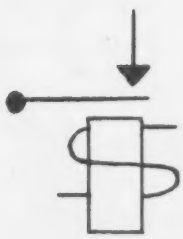
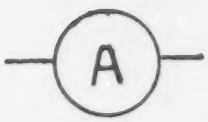


V

MOT




A

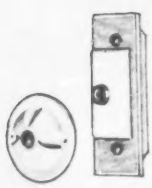
ASSIGNMENT:

Match the picture with its symbol. Write the number of the picture on the blank line next to the symbol on the next page.

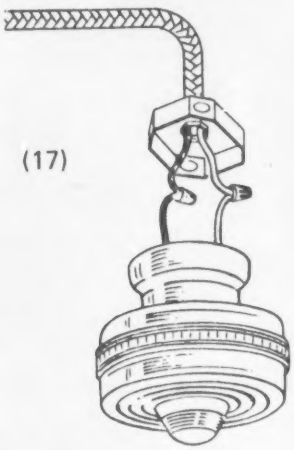
(14)

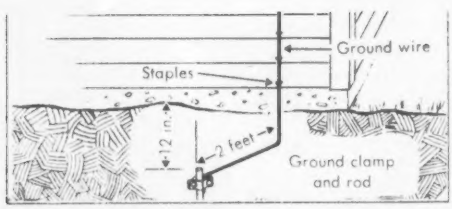
(15)

(16)



(17)





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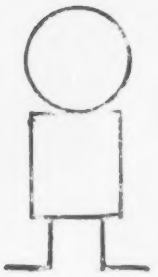
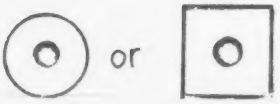



or

UNIT III - ELECTRICAL SYMBOLS AND CIRCUITS

Electric Circuits **Lesson 2**

OBJECTIVE:

When you have completed this lesson you will know the main parts of an electric circuit. You will know what a complete and incomplete circuit is.

VOCABULARY:

circuit – (sėr'-kit) – a path for electricity.
complete – (kum-plēt') – whole or perfect.
incomplete – (in'-kəm-plēt') – not perfect; not finished.
source – (sôrs) – where something starts; where something comes from.
device – (di-vīs') – a small tool or machine.

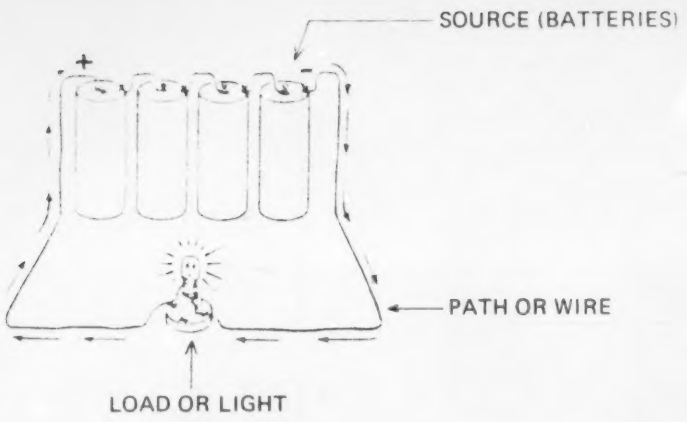
INFORMATION:

The electric circuit is the path the electric current uses as it goes through the wires. The path must be complete – like a round trip in a car – or electricity will not be able to travel. A complete electric circuit must have these three parts:

1. A **source** of electricity (can be a battery).
2. A **wire** (or path) for the electricity to travel in.
3. A **load** - where the work is done (can be a bell or light).

Most electric circuits have *four* parts.

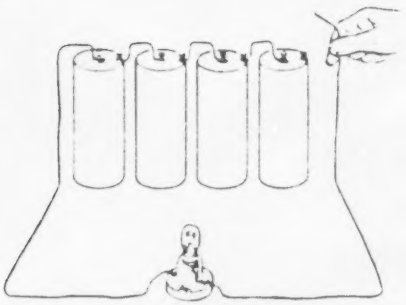
4. A **control device** (can be a pushbutton or switch) to turn the electricity on and off.



This is a complete circuit.

The arrows show the current traveling in the circuit.

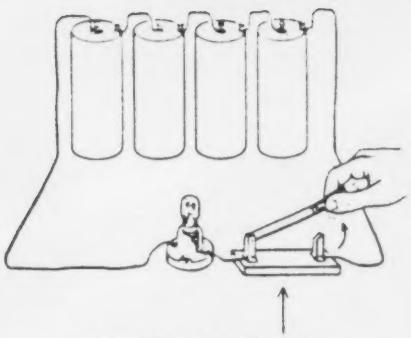
Work is being done. The light is on.



This is not a complete circuit; it is known as an incomplete circuit.

There is no current in this circuit.

There is no work being done. The light is off.



This is also an incomplete circuit.

The switch controls the circuit.

The switch is open and no current travels.

This circuit is also known as an open *circuit.*

ASSIGNMENT

1. A circuit that current can travel in is a _____ circuit.

2. Current will not travel in an _____ circuit.

3. A switch _____ a circuit.

4. Name the four main parts of a circuit.

   1. _____ 2. _____

   3. _____ 4. _____

5. In an electric circuit, the word PATH means _____.

UNIT III – ELECTRICAL SYMBOLS AND CIRCUITS

Electric Circuits Using Symbols **Lesson 3**

OBJECTIVE:

When you have completed this lesson, you will be able to draw many of the symbols used in electrical circuits.

VOCABULARY:

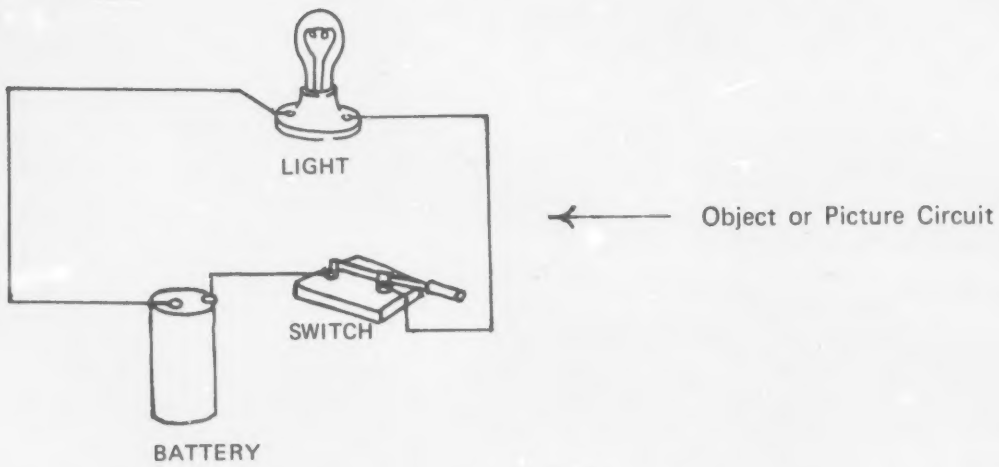
diagram – (dī′-ə-gram) -- a drawing that shows very clearly how something is done.

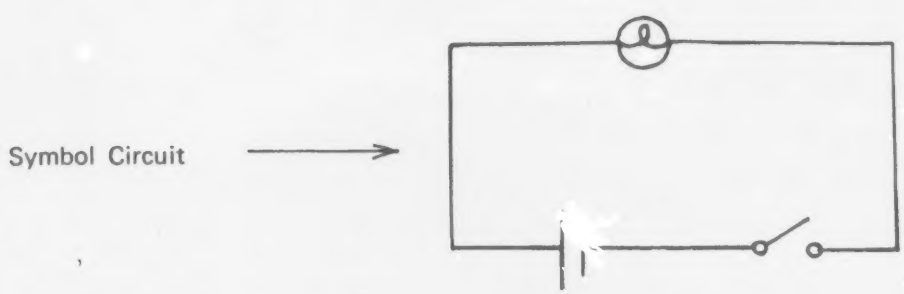
example – (ig-zam′-pl) – a sample; one thing taken to show what the others are like.

INFORMATION:

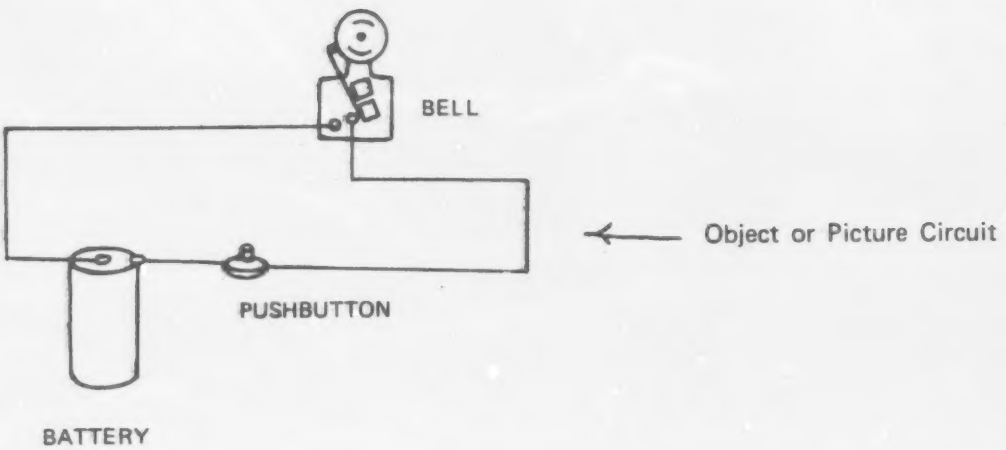
The following drawings are examples of object or picture circuits with their symbol circuits.

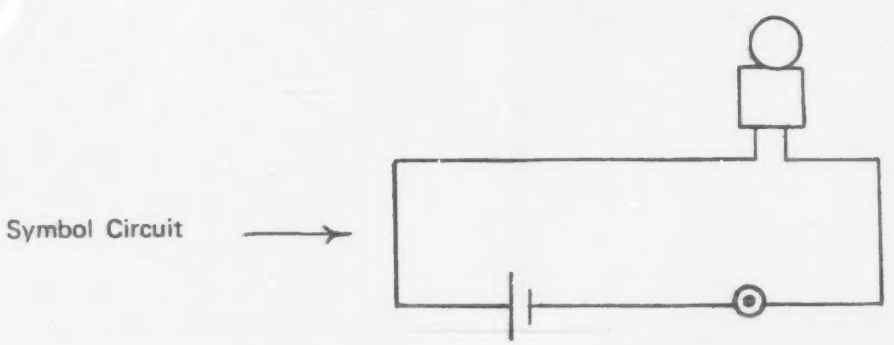
Symbol circuits are called *diagrams.*



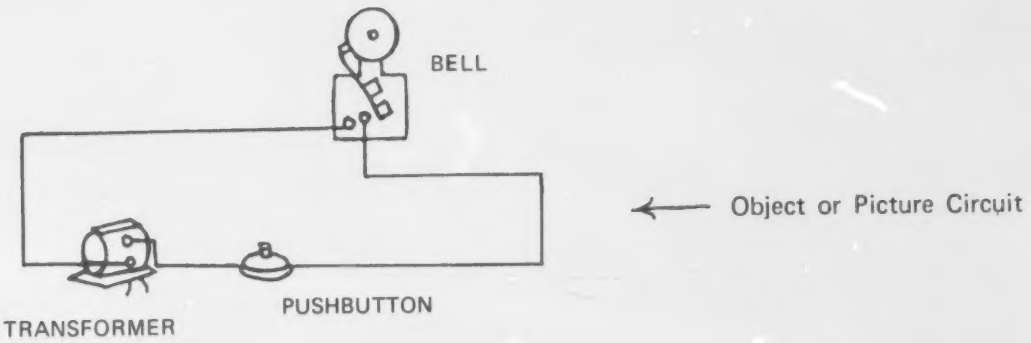


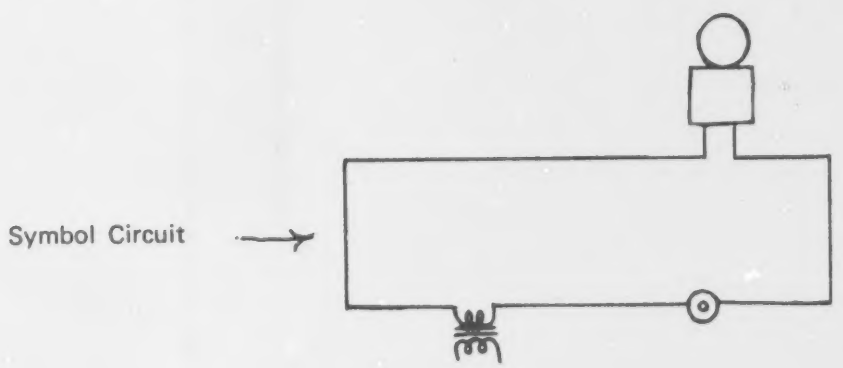
Light circuit with switch and battery.



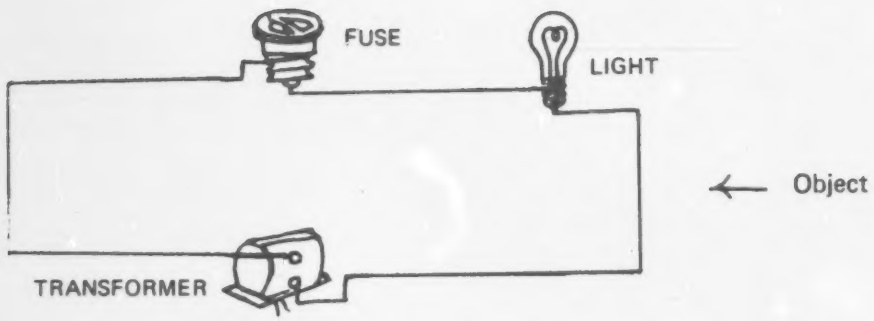


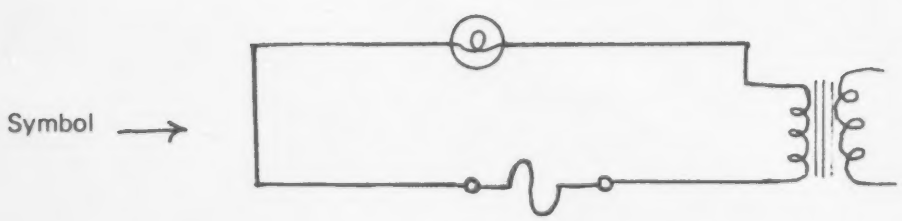
Bell circuit with pushbutton



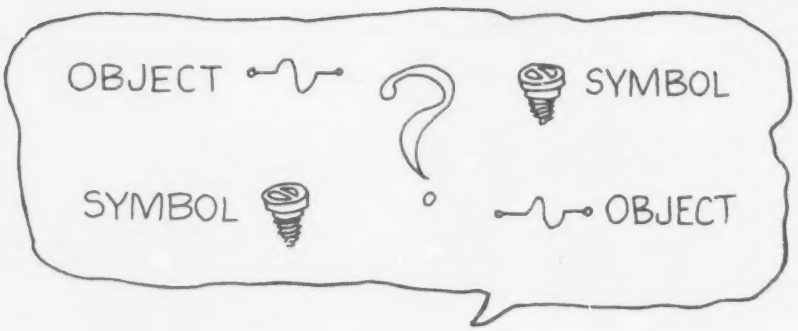


Bell circuit with transformer





Fuse circuit


OBJECT
SYMBOL
SYMBOL
OBJECT

ASSIGNMENT SHEET
1
2
3
4
5
6

ASSIGNMENT:

1. Draw the symbol for a bell.

2. Draw the symbol for a transformer.

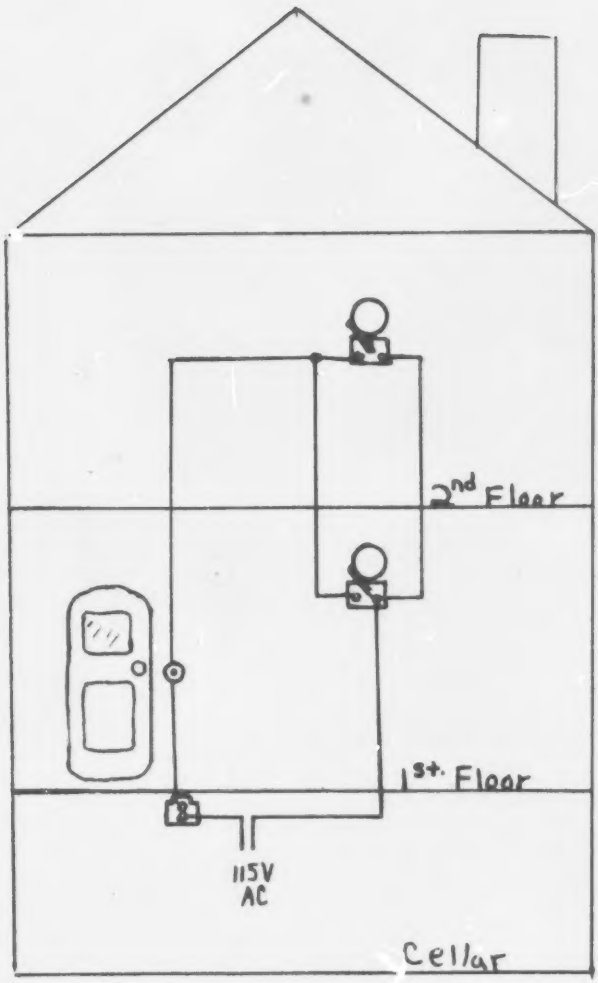
3. Draw the symbol for a switch.

4. Draw the symbol for a battery.

5. Draw the symbol for a pushbutton.

6. Draw the symbol for a fuse.

7. Draw the symbol for a light bulb.

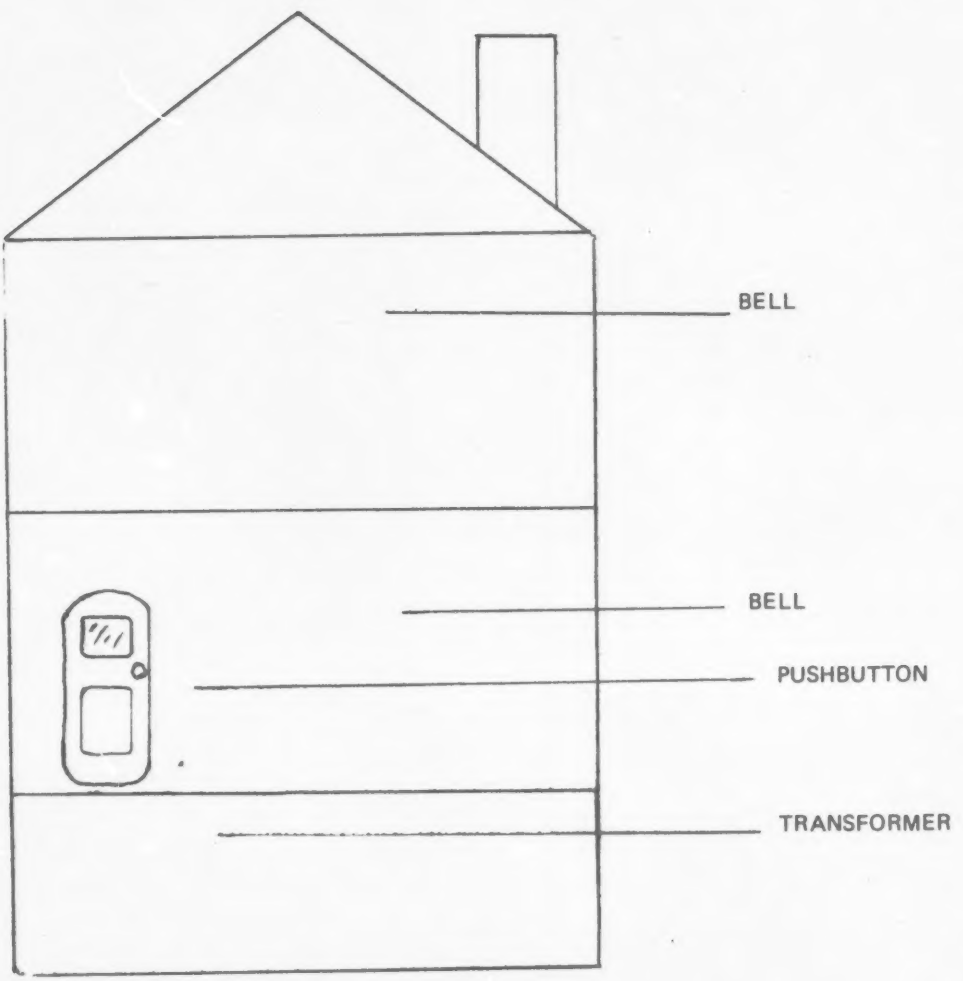


Door-Bell Circuit in a House

ASSIGNMENT:

Draw symbols in the house for each name you see.

Draw the wires to each symbol to make the circuit work.



UNIT III – ELECTRICAL SYMBOLS AND CIRCUITS

Series and Parallel Circuits **Lesson 4**

OBJECTIVE:

When you have completed this lesson you will be able to state the difference between series and parallel circuits. You will be able to trace the current-flow in series circuits and in parallel circuits.

VOCABULARY:

series circuit (sēr'-ēs) – circuit with the loads connected so that there is only one path for the current to follow.

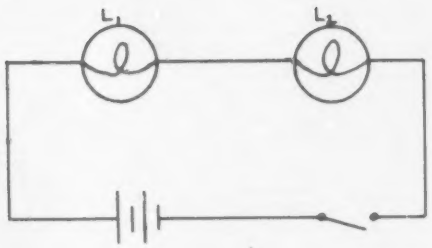
parallel circuit (par'-ə-lel) – circuit with the loads connected so that there is more than one path that the current can take.

trace (trās) – mark along a line.

appliance (ə-pli'-ənce) – a small machine used to do a certain special thing, like a toaster, an iron, a power saw, etc.

combination (kom-bi-nā'-shən) – a whole thing made by putting together two or more different things.

INFORMATION:



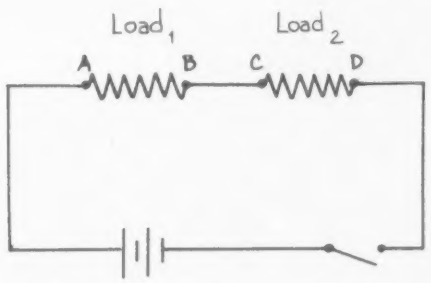
Series Circuit

Look at the diagram above. This is a *series* circuit. When the switch is closed, all the current from the batteries flows through both lamps. There is no other way for it to go.

Suppose one of the lamps burns out. The current cannot get through it. It acts like an open switch.

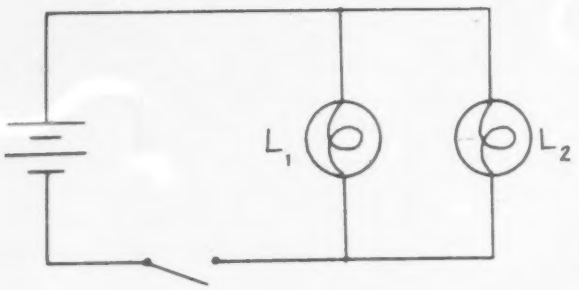
What would happen to the other lamp? It would go out.

To make a series connection, attach your wires in this way:



Series Circuit

Trace the current-flow when the switch is closed.



Parallel Circuit

Look at the diagram above. This is a *parallel* circuit. When the switch is closed, the current has *two* paths to follow.

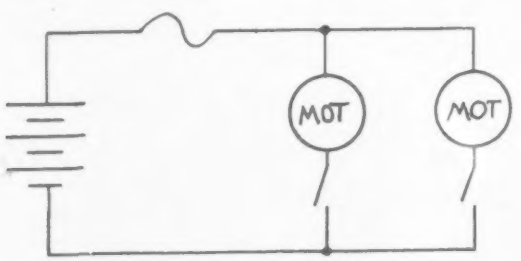
Trace the current that flows through L_1.

Trace the current that flows through L_2.

Suppose one of the lamps burns out. Current *can go* through the other lamp. The lamp will not go out.

The wiring in our homes is all connected in parallel. If a lamp or appliance burns out, the other lamps and appliances will still work.

Many circuits are *combination* (series and parallel) circuits.



Combination Circuit

In the above circuit, the *motors* are connected *in parallel*, and the *switches* are connected *in series with each motor*. The fuse is in series with both motors.

ASSIGNMENT:

1. Write in the word *series* or *parallel* for each sentence.

   a. All the current goes through each load. _____

   b. Some of the current goes through each load. _____

   c. The current divides into different paths. _____

   d. If one lamp burns out, the others will light. _____

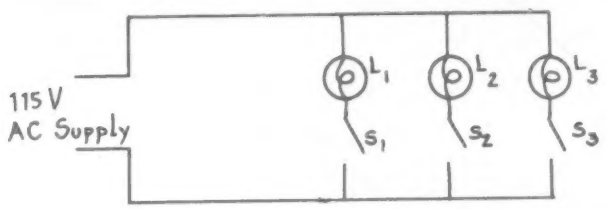
   e. If one lamp burns out, the others will not light. _____

   f. The wiring in our homes. _____

2. Below is a diagram of the circuit in a floor lamp with three bulbs and three switches.

   a. Trace the current-flow in the circuit when all three switches are closed.

   b. Trace the current flow when only S_2 is closed.



   c. Tell what will happen if you remove lamp bulb L_3 and then turn on all three switches.

3. Look at the drawing on page 81.

How is the pushbutton wired? _____ (in series, in parallel).

How are the door-bells wired? _____ (in series, in parallel).